SCIENCE

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CHARLES SEDGWICK MINOT[1]

I WISH to dwell in this paper not on the scientific attainments and successes of Charles Sedgwick Minot, but on the mental and moral qualities which his career illustrates and which made him what he was.

Young Minot did not follow the traditional course of education for the son of a well-to-do Boston lawyer. He did not go to Harvard College, but to the Massachusetts Institute of Technology and his first degree, that of bachelor of science, was obtained from that technical school. His major subject in that school was not the common one of engineering, but the uncommon one of natural history. He later pursued his studies in this unusual subject at Leipzig, Würzburg and Paris. Then, returning to Boston, he took the degree of doctor of science at Harvard University in 1878, again in the subject of natural history. His education, therefore, showed his determination in following his bent. and his independence in parting from his boyhood associates and his family's habitual practise in regard to the education of sons.

Then, as now, the only career open to students of natural history was a professorship in some branch of that subject, but this was not the career to which Minot looked forward. His studies were all histological and embryological, and their most practical and useful applications seemed to him to lie somewhere in the field of medical science and education.

Two years later he accepted two ap-

[1] Address before the Boston Society of Natural History at a memorial meeting held on March 17, 1915.

pointments in connection with Harvard University; one an appointment as lecturer in embryology in the medical school; the other an appointment as instructor in oral pathology and surgery in the dental school.

These appointments were procured for him with some difficulty, for he was not a doctor of medicine, and it was an unwelcome idea for the medical faculty that any instruction whatever should be given in the medical school by a person who had never taken the degree of doctor of medicine.

He accepted both these appointments with alacrity, although dentistry was not recognized then as a medical specialty, and immediately showed himself to be a competent lecturer and laboratory teacher in subjects which depended on the facile use of the microscope by both teacher and students. The place he took in the dental school had, just previously, been filled by Arthur Tracy Cabot, who had shown by his acceptance of that appointment his sympathy with the efforts of the university to lift and improve the dental school and the dental profession, and his prophetic belief that the relations between dentistry and clinical medicine were to become much more intimate than they had been.

In 1883, Minot was advanced to the position of instructor in histology and embryology, and this subject was given a satisfactory place in the curriculum of the medical school. There was still resistance to the appointment of a teacher who did not hold the degree of doctor of medicine, but Minot had, in three years, proved not only that he was the vigorous teacher, but that he had business qualities which would make him a remarkably good director of a laboratory for the instruction of medical students. He devised an excellent method of buying microscopes for the whole class and loaning them to students for a term fee which was sufficient to keep every microscope in repair and in time to repay their whole cost.

He studied every detail of the furniture and fittings of a medical laboratory and decided on the shape and the size of the desk room which each student needed. He made highly intelligent use of the card catalogue for his growing collection of embryological specimens, for his library and for his student records. He became expert in everything relating to the conduct of a laboratory and set a good example to all the other teachers who were conducting laboratories in the medical school. As the school was then in the process of changing from a school in which the lecture predominated to a school in which the laboratory predominated, Minot became more and more useful to the medical school as a whole.

In the year 1887, it was possible to appoint him to an assistant professorship of histology and embryology. At the expiration of the usual term for an assistant professor (five years) he was made professor of histology and human embryology, and in this appointment, with its new title, Minot's special subjects and his high merits both in teaching and in research were fully recognized.

Between 1881 and 1883, the medical faculty planned and erected a new building for its own use on Boylston Street, at the corner of Exeter Street—a building in which laboratories occupied a large part. Minot obtained for his courses an excellent laboratory of his own planning. There, in twenty years, he built up his unique embryological collection; a monument to his insight, skill, industry and power of inspiring others with his own zeal. In less than twenty years this building became inadequate for the best development of the medical school, and the new buildings of 1905 began to be planned. The fundamental consideration in planning and constructing the new buildings was to adapt them thoroughly to the new method of instruction in

medicine—a method which relied chiefly on individual instruction and laboratory work. Minot's careful study of the best laboratory conditions for small sections, in well-lighted and well-ventilated rooms, with a desk for each student, was taken up again and contributed much to the final success of the architect's plans. The accommodations for the department of histology and human embryology conformed to Minot's conception of the present and future needs of his department and served as a type for the laboratories of other departments in the school.

It became possible to enlarge the number of teachers employed in the department, and its intimate connection with the teaching of anatomy was recognized. When Dr. Thomas Dwight, professor of anatomy since 1883, died in 1911, the school was fully prepared to recognize the fact that anatomy and histology belonged together. In the mean time, the James Stillman professorship of comparative anatomy had been endowed and to that Professor Minot had been transferred in 1905. No professor of anatomy was appointed to succeed Dr. Dwight, but in 1912 Minot was made director of the anatomical laboratories in the Harvard Medical School. This action of the faculty and the corporation crowned Minot's professional career as a student and teacher of natural history, applied in medical education. By clear merit he had made his way and the way of his department in the school and without a medical degree had become the head of anatomical teaching in a medical school. Under him in the anatomical department were two assistant professors, one of whom was called assistant professor of anatomy and the other of histology. Fourteen other teachers were employed in the department of anatomy and histology, three of whom bore the title of histology and embryology, Minot's original subjects in the medical school.

Minot's advance through the medical school was not facilitated by a yielding or compromising disposition, or any practise of that sort on his part. On the contrary, he pursued his ends with clear-sighted intensity and indomitable persistence; suavity and geniality were not his leading characteristics in discussion or competition and he often found it hard to see that his opponent had some reason on his side. Like most independent and resolute thinkers, he had confidence in the soundness of his own reasoning, and in the justice of the cause or movement he had espoused.

He was upright in every sense of that word. His loyalty was firm and undeviating, whether to an ideal or a person or an institution, and affection and devotion, once planted in his breast, held for good and all.

His book on "Human Embryology" published in 1892 made him famous throughout the learned world, so that he was elected to learned societies in Great Britain, Italy, France, Germany and Belgium; as well as to all appropriate American societies. He also received honorary degrees from the universities of St. Andrew's (Scotland), Oxford (England), Toronto (Canada), and Yale. He enjoyed calmly and simply the honors thus paid to his scientific attainments and services by well informed and impartial judges.

In 1913 he was Harvard exchange professor at the universities of Berlin and Vienna, where he gladly availed himself of many opportunities to expound to his German colleagues the advances in natural history, including medicine, which were due to American investigators.

His hair and beard were now whitening, but he felt all the ardors of youth, and among them, fervid patriotism. In scientific investigation Minot showed imagination, penetration and eagerness, but also caution. In 1907 he gave a course of lectures at the Lowell Institute on "Age,

Growth and Death" and made them the basis of a book published the following year. For him, the subject meant cell metamorphosis, with which he had been familiar through all his studies in histology and embryology, but what he sought in this subject of "Age, Growth and Death" was a scientific solution of the problem of old age which should have—I quote his words—"in our minds, the character of a safe, sound and trustworthy biological conclusion." He ventured to think that some contemporary students of the phenomena of longevity had failed to exercise sufficient caution in forming their conclusions. Nevertheless, Minot was a scientific optimist; full of hope for perpetual progress and for useful results at many stages of the long way. These characteristics appeared clearly in the following passage, taken from the first lecture of that course at the Lowell Institute:

> I hope before I finish to convince you that we are already able to establish certain significant generalizations as to what is essential in the change from youth to old age, and that in consequence of these generalizations now possible to us new problems present themselves to our minds, which we hope really to be able to solve, and that in the solving of them we shall gain a sort of knowledge which is likely to be not only highly interesting to the scientific biologist, but also to prove in the end of great practical value.

There spoke the cautious, modest, hopeful scientist, expectant of good. Such is the faith which inspires the devoted lives of scientific inquirers.

CHARLES W. ELIOT

THE STIMULATION OF GROWTH[1]

I

THE growth of living organisms differs from that of crystals in three essential features. While the crystal grows only in a supersaturated solution of its own substance, living organisms can grow indefinitely in even a very low concentration of their nutritive solution; second, the nutritive solution need not and perhaps should not contain the compounds found in the cells, but only their split products, while in the case of the crystal the substance of crystal and solute must be identical. And thirdly, growth leads in living cells to the process of cell division as soon as the mass of the cell reaches a certain limit. Needless to say this process of cell division can not even metaphorically be claimed to exist in a crystal.

The fact that the cell can grow in a very low concentration of its nutritive solution, and the further fact that the nutritive solution only needs to contain the building stones for the complicated compounds of the cell, find their explanation in the assumption of the existence of synthetic enzymes or synthetic mechanisms in the cell.

The problem of growth is linked with that of death and immortality, since it would follow from our definition that the growth of a cell should go on eternally in a proper nutritive solution and under suitable conditions of temperature, provided that the synthetic catalyzers last and that they synthetize their own substance.[2] This is apparently true for bacteria and perhaps also for protozoa. Weismann has claimed immortality for all unicellular organisms and for the sex cells of metazoa, while he concedes mortality to the body cells. Leo Loeb recognized that immortality may be claimed also for the cells of malignant tumors, like cancer, for he had found that when he transplanted cancer cells on other animals the cells of the original cancer and

[1] Read at the meeting of the National Academy in Washington, April 19, 1915.

[2] This latter assumption leads to the connection of the problem of growth with that of autocatalysis as suggested first by the writer in 1906 and worked out subsequently in the papers of Wo. Ostwald and T. B. Robertson.